

CLAIMS:

1. A capacitive plasma enhanced chemical vapor deposition reactor comprising:

a processing chamber;

a susceptor electrode within the chamber configured to support at least one semiconductor workpiece;

a shower head electrode within the chamber operably adjacent the susceptor electrode and configured to provide gaseous reactants into the chamber;

a single RF power generator operatively coupled with the susceptor electrode and the shower head electrode and configured to provide RF power thereto effective to develop a plasma processing environment within the chamber and a desired bias relative to the semiconductor workpiece; and

an RF power splitter operatively interposed the RF power generator and both the susceptor electrode and the shower head electrode, the RF power splitter configured to provide power from the RF power generator to both the susceptor and the shower head at a selected power ratio between the susceptor electrode and the shower head electrode.

1           2.     The plasma enhanced chemical vapor deposition reactor of  
2 claim 1, wherein the susceptor electrode and the shower head electrode  
3 have respective surface areas which are different from one another, and  
4 the selected power ratio is proportional to a surface area ratio  
5 therebetween.

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7           3.     The plasma enhanced chemical vapor deposition reactor of  
8 claim 1, wherein the selected power ratio is other than a 1:1 ratio.

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10           4.     The plasma enhanced chemical vapor deposition reactor of  
11 claim 1, wherein the RF power splitter comprises a center tapped  
12 transformer having at least two output terminals, individual output  
13 terminals being connected to a respective one of the susceptor electrode  
14 and the shower head electrode.

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16           5.     The plasma enhanced chemical vapor deposition reactor of  
17 claim 1, wherein:

18           the RF power splitter comprises a center tapped transformer;

19           the susceptor electrode and the shower head electrode have  
20 respective surface areas which are different from one another; and

21           the selected power ratio is proportional to a surface area ratio  
22 therebetween.

1           6.     The plasma enhanced chemical vapor deposition reactor of  
2     claim 1, wherein the susceptor electrode and the shower head electrode  
3     have respective surface areas which are substantially equivalent.

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5           7.     The plasma enhanced chemical vapor deposition reactor of  
6     claim 1, wherein the selected power ratio is adjustable.

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8           8.     The plasma enhanced chemical vapor deposition reactor of  
9     claim 1, wherein the RF power splitter comprises a transformer having  
10    a plurality of variably groundable windings for changing the selected  
11    power ratio.

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13          9.     The plasma enhanced chemical vapor deposition reactor of  
14    claim 1, wherein the susceptor electrode and the shower head electrode  
15    have respective surface areas which are substantially equivalent, and the  
16    selected power ratio is adjustable.

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18          10.    The plasma enhanced chemical vapor deposition reactor of  
19    claim 1, wherein the susceptor electrode and the shower head electrode  
20    have respective surface areas which are substantially equivalent, and the  
21    RF power splitter comprises a transformer having a plurality of variably  
22    groundable windings for adjusting the selected power ratio.

1 11. A plasma enhanced chemical vapor deposition reactor  
2 comprising:

3 a chamber defining a processing volume;

4 a first electrode operably associated with the chamber;

5 a second electrode operably associated with the chamber;

6 a single RF power generator; and

7 a transformer having an input side and an output side, the input  
8 side being connected to the RF power generator for receiving power  
9 generated thereby, and the output side having no more than two output  
10 terminals, one output terminal being connected to the first electrode,  
11 and the other output terminal being connected to the second electrode,  
12 the output side providing power to each of the first and second  
13 electrodes in accordance with a selected power ratio.

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15 12. The plasma enhanced chemical vapor deposition reactor of  
16 claim 11, wherein at least one of the electrodes is disposed inside the  
17 chamber and is configured for supporting a semiconductor workpiece.

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19 13. The plasma enhanced chemical vapor deposition reactor of  
20 claim 11, wherein one of the electrodes is disposed outside the  
21 chamber.

1 14. The plasma enhanced chemical vapor deposition reactor of  
2 claim 11, wherein both the first and second electrodes are disposed  
3 inside the chamber, the first electrode being configured for supporting  
4 a semiconductor workpiece.

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6 15. The plasma enhanced chemical vapor deposition reactor of  
7 claim 11, wherein the first and second electrodes comprise respective  
8 surface areas which are different from one another.

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10 16. The plasma enhanced chemical vapor deposition reactor of  
11 claim 11, wherein:

12 both the first and second electrodes are disposed inside the  
13 chamber, the first electrode being configured for supporting a  
14 semiconductor workpiece; and

15 the first and second electrodes comprise respective surface areas  
16 which are different from one another.

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18 17. The plasma enhanced chemical vapor deposition reactor of  
19 claim 11, wherein the transformer output side comprises a plurality of  
20 variably groundable windings for varying the selected power ratio.

1 18. A parallel plate plasma enhanced chemical vapor deposition  
2 reactor comprising:

3 a processing chamber;

4 a susceptor electrode in the chamber and configured to support  
5 at least one semiconductor workpiece, the susceptor electrode comprising  
6 a first surface area;

7 a shower head electrode in the chamber and configured to provide  
8 reactants into the chamber, the shower head electrode comprising a  
9 second surface area which is less than the first surface area; and

10 a single RF power source operatively coupled to both the shower  
11 head electrode and the susceptor electrode and configured to provide  
12 RF power to each electrode according to a predefined relative  
13 magnitude effective to develop a desired bias relative to a  
14 semiconductor workpiece supported by the susceptor electrode and to  
15 develop a plasma processing environment within the processing chamber.

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17 19. The parallel plate plasma enhanced chemical vapor  
18 deposition reactor of claim 18, wherein the predefined relative  
19 magnitude is directly proportional to the inverse ratio of the 4th power  
20 of the areas of the electrodes.

1        20. A parallel plate plasma enhanced chemical vapor deposition  
2 reactor comprising:

3        a processing chamber;

4        a susceptor electrode within the chamber configured to support at  
5 least one semiconductor workpiece, the susceptor electrode having a  
6 susceptor surface area;

7        a shower head electrode within the chamber operably adjacent the  
8 susceptor electrode and configured to provide gaseous reactants into the  
9 chamber, the shower head electrode having a shower head surface area  
10 which is smaller than the susceptor electrode surface area;

11       a single RF power generator operatively associated with the  
12 processing chamber and configured to provide RF power;

13       a center tapped transformer having an input side and no more  
14 than two output terminals, the input side being operably connected with  
15 and capable of receiving RF power from the RF power generator, and  
16 individual respective output terminals being connected with the susceptor  
17 electrode and the shower head electrode and configured to provide RF  
18 power to each electrode at a selected power ratio which is proportional  
19 to a ratio of the areas of the electrodes.  
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1           21. A plasma enhanced chemical vapor deposition reactor  
2 comprising:

3           a processing chamber;

4           a first electrode inside the chamber and configured for supporting  
5 a workpiece;

6           a second electrode operably associated with the chamber;

7           a single RF power generator configured to provide RF power;

8           a transformer having an input side and an output side with only  
9 two output terminals which form individual connections with any of the  
10 reactor's electrodes, the input side being operably connected with and  
11 receiving power from the RF power generator, the output terminals  
12 being configured to provide RF power to each electrode at a selected  
13 power ratio which is effective to both (a) develop a desired bias  
14 relative to a workpiece, and (b) establish and maintain a plasma  
15 processing environment inside the processing chamber; and

16           the output side further comprising a plurality of windings  
17 individual windings of which can be selectively grounded for varying the  
18 RF power provided to the respective electrodes and the selected power  
19 ratio thereof.

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21           22. The plasma enhanced chemical vapor deposition reactor of  
22 claim 21, wherein the reactor is an inductive coil reactor and the  
23 second electrode is disposed outside the chamber.  
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1           23. The plasma enhanced chemical vapor deposition reactor of  
2 claim 21, wherein the reactor is a parallel plate reactor and the second  
3 electrode is disposed inside the chamber.

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5           24. A semiconductor processing method of plasma enhanced  
6 chemical vapor depositing material over a semiconductor workpiece  
7 within a processing chamber comprising:

8           providing a first electrode for supporting a workpiece;

9           providing a second electrode operably associated with the chamber,  
10 the first and second electrodes constituting the only processing chamber  
11 electrodes relative to which a desired bias is to be developed and a  
12 plasma processing environment is to be created;

13           applying RF power to both the first and second electrodes from  
14 a single RF power generator, the applied power defining a selected  
15 power ratio between the first and second electrodes which is other than  
16 a 1:1 ratio; and

17           providing at least one reactive gas within the processing chamber  
18 effective to chemical vapor deposit a layer of material on a wafer  
19 supported by the first electrode within the processing chamber.

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21           25. The semiconductor processing method of claim 24, wherein  
22 the second electrode is provided inside the chamber.  
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1           26. The semiconductor processing method of claim 24, wherein  
2 the second electrode is provided outside the chamber.

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4           27. The semiconductor processing method of claim 24, wherein:  
5 the second electrode is provided inside the chamber;

6 the first electrode comprises a susceptor electrode having a  
7 defined surface area;

8 the second electrode comprises a shower head electrode having a  
9 defined surface area, the shower head electrode being configured to  
10 provide reactants into the chamber; and

11 the respective surface areas of the first and second electrodes are  
12 different from one another.

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14           28. The semiconductor processing method of claim 24, wherein  
15 the applying step comprises:

16 forming an operative connection between the first electrode, the  
17 second electrode, and an RF power splitter;

18 forming an operative connection between the RF power splitter  
19 and the single RF power generator;

20 splitting RF power supplied by the RF power generator into first  
21 and second power components;

22 applying the first power component to the first electrode; and

23 applying the second power component to the second electrode.  
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1           29. The semiconductor processing method of claim 24, wherein  
2 the applying step comprises:

3           forming an operative connection between the first electrode, the  
4 second electrode, and a transformer having an input side and an output  
5 side, the first and second electrodes being operatively coupled with the  
6 transformer output side;

7           forming an operative connection between the transformer input  
8 side and the single RF power generator;

9           splitting RF power supplied by the RF power generator into first  
10 and second power components;

11           applying the first power component to the first electrode; and

12           applying the second power component to the second electrode.  
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1           30. The semiconductor processing method of claim 24, wherein  
2 the applying step comprises:

3           forming an operative connection between the first electrode, the  
4 second electrode, and a transformer having an input side and an output  
5 side, the first and second electrodes being operatively coupled with the  
6 transformer output side;

7           forming an operative connection between the transformer input  
8 side and the single RF power generator;

9           splitting RF power supplied by the RF power generator into first  
10 and second power components;

11           applying the first power component to the first electrode;

12           applying the second power component to the second electrode;

13 and

14           wherein the transformer output side comprises a plurality of  
15 variably groundable coils for enabling the respective magnitudes of the  
16 first and second power components to be varied.

1           31. A semiconductor processing method of plasma enhanced  
2 chemical vapor depositing material over a semiconductor workpiece  
3 within a processing chamber comprising:

4           providing a first electrode inside the chamber for supporting a  
5 workpiece;

6           providing a second electrode inside the chamber;

7           providing a transformer having an input side and an output side,  
8 the output side comprising a plurality of coils, one of the coils  
9 comprising a center coil;

10          forming an operative connection between the transformer input  
11 side and a single RF power generator, the generator being configured  
12 to provide RF power to the transformer input side and comprising the  
13 only RF power source which is operably associated with the processing  
14 chamber;

15          forming an operative connection between the transformer output  
16 side and the first and second electrodes, said connection comprising the  
17 only connection between the transformer and any processing chamber  
18 electrode;

19          grounding one of the transformer output side coils other than the  
20 center coil to produce first and second power components which are  
21 different in magnitude from one another, the first power component  
22 being applied to the first electrode and the second power component  
23 being applied to the second electrode; and  
24

1 providing at least one reactive gas within the processing chamber  
2 effective to chemical vapor deposit a layer of material on a wafer  
3 supported by the first electrode within the processing chamber.  
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5 32. The semiconductor processing method of claim 31, wherein  
6 the first power component is greater than the second power component.

7 33. The semiconductor processing method of claim 31, wherein  
8 the transformer is capable of having others of the plurality of output  
9 side coils selectively grounded for varying the relative magnitudes of the  
10 first and second power components.  
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1           34. A semiconductor processing method of chemical vapor  
2 depositing material over a semiconductor workpiece within a processing  
3 chamber comprising:

4           splitting RF power produced by a single RF power source into  
5 first and second RF power components of different magnitudes, the  
6 single RF power source comprising the only RF power source which is  
7 associated with the processing chamber;

8           powering only two processing chamber electrodes with the  
9 respective different magnitude first and second RF power components;  
10 and

11           providing at least one reactive gas within the processing chamber  
12 effective to chemical vapor deposit a layer of material on a wafer  
13 supported by one of the electrodes within the processing chamber.

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15           35. The semiconductor processing method of claim 34, wherein  
16 the powering comprises:

17           powering a first electrode with the first RF power component, the  
18 first electrode supporting at least one semiconductor workpiece for  
19 processing; and

20           powering a second electrode with the second RF power  
21 component, the second electrode being powered to a greater magnitude  
22 than the first electrode.  
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1           36. The semiconductor processing method of claim 34, wherein  
2 at least one of the processing chamber electrodes is disposed on the  
3 exterior of the processing chamber.

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5           37. A semiconductor processing method of effecting plasma  
6 enhanced chemical vapor deposition comprising applying RF power to  
7 only two electrodes comprising part of a plasma enhanced chemical  
8 vapor deposition reactor from a single RF power generator during  
9 deposition, the single RF power generator comprising the only RF  
10 power generator which is associated with the reactor.

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12           38. The semiconductor processing method of claim 37, wherein  
13 the electrodes are disposed interiorly of the reactor and have respective  
14 surface areas which are different from one another.

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16           39. The semiconductor processing method of claim 37, wherein  
17 at least one of the electrodes is disposed interiorly of the reactor.

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19           40. The semiconductor processing method of claim 37, wherein  
20 the reactor is an inductive coil reactor.

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22           41. The semiconductor processing method of claim 37, wherein  
23 the RF power is applied to the electrodes according to a selected  
24 power ratio other than 1:1.